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Research Management Division Review for the Fiscal Year 1983/84

RMD Report 85/29

Alberta
ENVIRONMENT
Environmental Protection Services
Research Management Division

RESEARCH MANAGEMENT DIVISION EMBLEM

The emblem represents the interdisciplinary and holistic nature of the Division's environmental research programs. Each of the five sections of the symbol represent comprehensive programs on air, water, land, humans and their constant interaction. The sections converge to form a cohesive chain, characteristic of an effective research organization. This cohesive bonding makes the sections blossom into the environment in the form of a flower — an Albertan wild rose.

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RESEARCH MANAGEMENT DIVISION
REVIEW
FOR THE FISCAL YEAR
1983/84

RESEARCH MANAGEMENT DIVISION
Alberta Environment

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REVIEW
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1983/84

RESEARCH MANAGEMENT DIVISION
Alberta Environment

RMD Report 85/29

1985

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INTRODUCTION

The objectives of the Research Management Division (RMD) are:

1. To provide timely and authoritative scientific and technical information to other operational divisions within Alberta Environment;
2. To plan and co-ordinate the scientific environmental research requirements of the department; and
3. To carry out research on environmental matters which is pertinent to departmental and provincial needs.

In order to effect these objectives, the division combines diverse skills, such as project management, budgeting and financial control, contracting, and publication editing, with comprehensive knowledge in many scientific areas pertinent to environmental research. The division's expertise, which allows for a comprehensive approach to environmental problem solving, is drawn from such fields as hydrology, climatology, pedology, biology, meteorology, ecology, and sociology.

Divisional Organization

The organizational structure of RMD merges a functional management mode, comprised of four scientific systems or working groups (air, human, terrestrial, and aquatic), into a matrix system with a number of well-defined scientific research programs. The prime advantage of this structure is its flexibility, allowing for an interdisciplinary approach to certain environmental problems. For instance, the division's work in the area of acid deposition includes research on the complex interface between the atmosphere and biosphere, that is, how air quality affects soils and vegetation.

During the 1983/84 fiscal year, the division's research programs included:

1. The Alberta Oil Sands Environmental Research Program (AOSERP);
2. Acid Deposition;
3. Environmental Assessment;
4. Environmental Contaminants;
5. Reclamation;
6. Socio-Economic Analysis; and
7. Waste Management.

In addition, the Environmental Emergencies, Risk Analysis, and Technological Assessment programs remained under review. These programs will be realigned in 1984/85 to better reflect departmental needs and priorities.

As RMD's programs are developed, each is defined by a comprehensive description document that is updated regularly in order to keep its objectives current. Environmental concerns in Alberta are continually being examined and may be incorporated into the division's active programs. Should it be necessary, new programs are developed. As well, in this updating process other programs may be terminated. Budget funds are allocated to each of the programs on the basis of priorities determined by Alberta Environment.

AOSERP was initiated in 1975 to investigate the potential environmental effects of industrial development in the Athabasca Oil Sands. At that time, the program was confined to a specific study area which has since been expanded to include other oil sands areas, most notably Cold Lake. To support AOSERP research, the Research Management Division operates the Mildred Lake Scientific Research Facility, consisting of laboratory and camp space for project and scientific staff working in the Athabasca Oil Sands area.

In its research service role within Alberta Environment, the Research Management Division aids in the co-ordination of all of the department's environmental research and ensures that the available research dollars are well spent on activities that respond to high priority needs. To this end, RMD acts as a co-ordinator for research carried out on behalf of the department at the Alberta Environmental Centre in Vegreville. As well, divisional staff constantly interact with other line divisions of Alberta Environment in order to keep their programs current and of direct applicability to the department.

In its research management capacity, the Research Management Division actively manages or oversees a number of environmental research projects. As a rule, proposals for projects are solicited by RMD as needs are identified and terms of reference developed. However, proposals may also be submitted through other divisions of Alberta Environment. All are reviewed in the light of departmental objectives and the division's program requirements.

Operational Activities

During the fiscal year, the Research Management Division managed 55 contracts, ranging from major interdepartmental and interdisciplinary projects, such as the Cold Lake Hydrology Study, to the organization of small internal workshops and the publication of monographs in scientific journals. Twenty-two research projects were contracted to private consulting firms and 28 contracts were provided to universities, while the remainder were with government agencies such as the Alberta Research Council or were service contracts related to divisional operations. Fourteen grants were provided for environmental research, including funding for a number of symposia and workshops.

Thirty-one reports on research projects were published by RMD during the year and a number of articles relating to RMD projects appeared in scientific journals. Additionally, researchers submitted interim or progress reports, which were not published, on long-term projects. Staff members published material internally, through other agencies, or in conference proceedings or journals.

A large portion of staff time was spent participating in departmental, interdepartmental, and interagency committees, such as the Reclamation Research Technical Advisory Committee (RRTAC) and the Federal/Provincial Long-Range Transport of Atmospheric Pollutants (LRTAP) committee, which co-ordinate environmental research programs Involvement in these committees has enhanced the effectiveness of the division and its management capabilities and has ensured that the professional staff have maintained an awareness of current environmental research activities in Alberta and elsewhere.

Within the administrative arm of the Research Management Division, an emphasis was placed on improving the accessibility of sound data in order to monitor research projects. Foundations were laid for a computerized information management system which will be implemented in the future. This system will allow for more responsive administration of research in a rapidly changing environment.

A Note as to the Organization of This Report

This report is divided into sections describing major research programs operative in 1983/84. Where appropriate, specific reference may be made either to location of a project or to one of the four scientific systems or working groups. Projects relating to AOSERP (oil sands research) have been incorporated into the descriptions of the other programs. A separate annual report on AOSERP studies is published by RMD (AOSERP Annual Report No. 131, Alberta Environment, RMD, 1983/84).

ACID DEPOSITION RESEARCH PPOGRAM

The Acid Deposition Research Program was designed to plan and implement research specific to Alberta which would concisely address the following objectives:

1. To characterize sensitive environmental ecosystems and develop methodologies to identify and/or predict measurable short- and long-term effects of acidic or acidifying substances on Alberta ecosystems;
2. To determine the characteristics and quantities of both long-range emissions and those generated locally, and to examine their effects on the environment;
3. To develop a basis and approach for preventive strategies and environmental protection; and
4. To co-ordinate departmental research on acid deposition with other private and public agencies in Alberta and the rest of western Canada.

In 1983/84, work on acidic and acidifying substances was concentrated on characterizing and quantifying their ecological effects. Such research continued to be a major activity in the division. Considerable effort was expended to develop a more thorough understanding of the atmosphere-biosphere interface. A newly-developed model shows great promise for simulating this relationship.

The emissions of acid-forming substances into the atmosphere, and their deposition and subsequent impact on the ecosystem are of significant concern. Because the magnitude and intensity of deposition is irregular and sporadic, the response of vegetation to pollution episodes is dependent upon the relationship and timing of the incident and the physiological development of the receptor. Specific projects have been geared to the accurate and frequent measurements of pollutant concentration occurrences and their interface with physiological, phenological, and productivity responses in vegetation species. Data generated will be used to develop a computerized numerical model for integrating chronic air pollutant exposures and tree growth response. A second major interface, between soil nutrients, microbiological processes, and vegetation, is also being studied.

Regional surveys to sample and chemically analyse event rainfall and the snowpack for total pollutant loadings in the Athabasca Oil Sands region were continued. Wet deposition, however, is only one of two major mechanisms in the transfer of pollutants from source to receptor. Air pollutants released into the atmosphere are deposited continuously and cumulatively through both dry- and wetfall processes. Methodologies and instrumention technology for measuring dry deposition were developed and implemented in the field.

In conjunction with the aforementioned studies, research to determine the transport, dispersion, and transformation rates of oxides of sulphur and nitrogen emissions was continued. Such research is intended to facilitate the investigation of the medium- to long-range transport of acid forming emissions from a major emission source in the area.

The Acid Deposition Research Program will provide scientific information for reviewing and evaluating Alberta's air quality standards, will assist in the present and future planning of industrial development, and will enable a good understanding of the potential for environmental acidification. This program will thereby establish a basis for sound, long-term environmental management. These data will be used in the development of methodologies which will identify and/or predict environmental deterioration caused by acid-forming emissions.

The Research Management Division played a major role in the planning, development, and co-ordination of a major new program in Alberta during 1983/84, the Alberta Goverment/Industry Acid Deposition Research Program (AGIADRP). This important program is sponsored and managed on a 50-50 basis by government and industry and has an estimated budget of $8 million over the next seven years. The planning and development of subsequent phases of the departmental Acid Deposition Research Program, managed by the Research Management Division, will be integrated and co-ordinated with AGIADRP.

PROJECTS

Air Quality Data Acquisition

The emissions of acid-forming substances into the atmosphere, and their deposition and subsequent impact on the ecosystem are of current concern. Magnitude and intensity of deposition follows an episodic pattern. However the response of vegetation to pollution is dependent upon the relationship and timing of the episode and the physiological development of the receptor. Therefore air quality/atmosphere data must be interfaced with receptor-response measurements.

To facilitate the implementation of an ecological monitoring research program, an air quality monitoring station was established in the vicinity of a permanent sample plot on the Sandalta lease in the Athabasca Oil Sands area. The station continuously measures meteorological data and ambient concentrations of acid-forming gases, and takes integrated measurements of wet- and dryfall particulate matter. Data generated will be used to develop numerical models for interfacing atmospheric/air quality data to plant response measurements.

An interim report will be available from Research Management Division.

Contractor: D.S. Chadder, PROMET Environmental Group Ltd.

Funding: $70 000.00 (Research Management Division)

Aquatic Sensitivity Mapping

Phase I of this project involved the establishment of criteria for sensitivity of surface waters in Alberta to deposition of acid-forming emissions and the production of an initial set of aquatic sensitivity maps. These maps were prepared from an examination of all available sources of water quality data produced in Alberta.

Phase II of this project involves updating the preliminary maps with current monitoring data in order to fill in gaps of information indicated with the completion of Phase I.

Phase III of this project will investigate the application of the specific criteria for sensitivity to the Alberta situation by investigating a

connection between areas thought to be sensitive and predicted deposition. Field investigations, in specific areas, will verify depositional patterns and determine the actual response of those areas. This will then be compared to the predicted sensitivity patterns and will satisfy the sensitivity criteria developed in Phase I.

An interim report will be available from the Research Management Division.

Contractor: P. Erickson (private consultant)
Funding: $20 000.00 (Research Management Division)

Atmosphere-Biosphere Interface: Computerized Numerical Model for Lodgepole Pine Response to Chronic Atmospheric SO_2 Exposure; Analytical Design of Plant Response to SO_2 Exposure in Alberta (A Critical Review)

This study of lodgepole pine is an extension of an earlier interface project dealing with an agricultural crop. A mathematical model was derived and tested to determine the relationship between chronic atmospheric sulphur dioxide (SO_2) released by sour gas plants and tree growth responses.

A final report will be available late in 1984.

Contractor: M. Nosal, University of Calgary and Statscon Consulting
Funding: $25 000.00 (Research Management Division)

Chemistry of Summer Precipitation in the Athabasca Oil Sands Area

Atmospheric pollutants are scavenged from the air by rainfall. Analysis of this rain provides some indication of the amount and distribution of chemical elements and components that are present in the air. Projects to collect and chemically analyse rainfall on an event basis have been ongoing since 1976 in the Athabasca Oil Sands area. Emissions from industrial sources in this region are under careful scrutiny. Concern is that these parameters would change in space and time as a result of additional atmospheric emission sources. The continued monitoring will delineate any possible changes in the nature and spatial distribution of wetfall deposition from these sources.

Objectives of the study will be to: (1) identify trends in the chemical characteristcs of rainfall; (2) develop the most appropriate and

successful sampling and analysis techniques for precipitation chemistry; and (3) provide a data base to quantify changes in the input rate of atmospheric trace substances into sensitive ecosystems.

Contractor: D.S. Chadder, PROMET Environmental Group Ltd.
E. Peake, Kananaskis Centre for Environmental Research
N. Das, Alberta Environmental Centre

Funding: $56 000.00 (Research Management Division)

Chemistry of Winter Precipitation in the Athabasca Oil Sands Area

As an ongoing project since 1976, the accumulated snowpack in the Athabasca Oil Sands area has been extensively sampled and chemically analysed. The primary objectives of the project have been to quantify the total ionic and particulate loading of the snowpack and to qualitatively assess the spatial distribution of pollutant deposition resulting from the emissions from industrial sources in the area. This information will provide baseline data required to assess the impact of future industrial developments in the area. Developmental research work was also implemented which would investigate the chemical composition of meltwater, and the fractionation of ions during snowmelt.

Contractor: D. LaBerge, CHEMEX Labs (Alberta) Ltd.

Funding: $40 000.00 (Research Management Division)

Determination of Dispersion, Pollutant Trajectories, and Precipitation-Acidifying Processes through Aircraft Measurements

Initiated in 1982 as a co-operative effort between the Alberta Research Council and the Research Management Division, this project investigates the dispersion and transport of sulphur dioxide and oxides of nitrogen from point source plumes in the oil sands area near Fort McMurray. The chemical transformation and rate of removal of these acid-forming emissions by both clouds and precipitation will also be investigated. The airborne field measurements will provide baseline information for future pollutant trend analyses and will be vitally important for tracking pollutant/air mass trajectories from the emission sources.

An interim report will be available from Research Management Division.

Contractor: M. English and L. Cheng, Alberta Research Council

Funding: $50 000.00 (Research Management Division)
$50 000.00 (Alberta Research Council)

Dry Deposition of Acid-Forming Emissions in Alberta

The measurement of acid-forming emissions deposition relies on two components both wet- and dryfall accumulation. In Alberta, dry deposition is considered to be at least as important as wet deposition; unfortunately dry deposition rates are not well documented. This project, currently being conducted in the Athabasca Oil Sands area, will continuously measure ambient concentrations of sulphur dioxide and collect integrated data on the quality and quantity of dry- and wetfall particulate matter. This study will promote the development and field testing of measurement techniques for the dry deposition of sulphur dioxide and the subsequent derivation of dry deposition velocities.

The project is a specific component of an integrated research effort to assess the impact of total acid deposition on terrestrial ecosystems. It will provide the information necessary to assess the total deposition occurring in the vicinity of an oil sands plant and to define source-receptor relationships.

An interim report will be available from Research Management Division.

Contractor: D.S. Chadder, PROMET Environmental Group Ltd.

Funding: $87 000.00 (Research Management Division)

Effects of Deposition of Acid-Forming Substances on Nutrient Cycling in a Forest Ecosystem

The effects of deposition of acid-forming substances on: (1) nutrient release from decomposing litter; (2) distribution and leaching characteristics of key nutrients in the litter/soil system; and (3) the uptake of nutrients by mycorrhizal and non-mycorrhizal jackpine seedlings will be studied.

The first annual report is available from Research Management Division.

Contractor: D. Parkinson, University of Calgary

Funding: $40 688.00 (Research Management Division)

Fffects of Deposition of Acid-Forming Substances on Organic Matter Decomposition and Microbial Activity

This study will investigate organic matter transformations in the litter layer of jackpine woodland ecosystems under different levels of impact from acid-forming emission substances. Sampling of litter fall, decomposition rates, biological activity and total microbial biomass will be done. Major reactions in carbon (energy) flow are to be measured and correlated with the impact of acid-forming substances.

The first annual report is available from Research Management Division.

Contractor: D. Parkinson, University of Calgary

Funding: $29 159.00 (Research Management Division)

The Effects of Nitrogen Oxides on Native Vegetation, Soils, and Water near a Compressor Installation

The sensitivity of select natural plant species to injury by low concentrations of nitrogen oxide and/or nitrogen dioxide stress was determined. Also examined were the effects of nitrogen oxides on the availability of certain plant nutrients in the soil. These studies will be integrated with the compressor station-ecosystem distribution inventory for Alberta, as well as with information on known emissions of oxides of nitrogen.

A final report will be available late in 1985.

Contractor: A. Legge, University of Calgary

Funding: $95 000.00 (Research Management Division)

$30 000.00 (Standards and Approvals Division)

The Effect of SO_2 Emitted from a Sour Gas Plant on the Development of Endomycorrhizae (VA) on Phleum pratense

The physiological effects of sulphur dioxide (SO_2) on Phleum pratense will be related to the subsequent effect on endomycorrhizae (VA) inhibiting the roots of this agriculturally important species. Laboratory fumigation and field site experiments over a two-year period will be used to monitor the effects on mycorrhizal root infection, root biomass, and root exudation.

The final report, in the form of a thesis, will be available upon completion of the degree.

Contractor: J. Clapperton, University of Calgary
Funding: $5 625.00 (Research Management Division)

Impacts of Air Pollutant Mixtures on Forest Vegetation and Soils

The study is designed to use both laboratory and field investigations to identify and quantify forest tree responses to single and multiple exposures of acid-forming pollutants. For the Athabasca Oil Sands area, a predictive capability for changes in forest soils and vegetation will be made. Both current and future rates of pollution deposition are being considered.

Annual reports are available from Research Management Division.

Contractor: P. Addison, Canadian Forestry Service
Funding: $30 000.00 (Research Management Division)

Nutrient Redistribution in Jackpine as an Indication of Acid Deposition Stress

The feasibility of using non-destructive analytical methods to detect changes in tree wood chemistry is being examined. Tree cores will be analysed for temporal nutrient changes and related to the emissions of oil sands plants in the Fort McMurray area.

A final report will be available late in 1985.

Contractor: A. Legge, University of Calgary
Funding: $40 800.00 (Research Management Division)

Protection of the Biotic Environment

This study attempted to evaluate the relative effects of natural and anthropogenic (pollutants) factors on forest ecosystems. Morphologic and growth responses (past and present) in jackpine stands throughout the Athabasca Oil Sands were studied to determine if pollution effects can be identified and quantified. The research was carried out under the auspices of an Alberta Oil Sands Technology and Research Authority Professorship.

The final report is in preparation.

Contractor: C. Pielou, University of Lethbridge

Funding: $38 308.00 (Grant to University of Lethbridge Professorship) (Research Management Division)

$14 100.00 (Research contract) (Research Management Division)

The Response of Vegetation Communities to Aerial Emissions

This project will determine structural dynamics in the boreal forest in order to compare any natural changes to those induced by aerial emissions. Results from this project will be issued, in conjunction with findings from other studies, to develop sensitive and predictive indicators of effects of aerial emissions on forest ecosystems (as an early warning). This study will involve process-related phenomena and will establish the relationship between changes occurring in these processes, and the structure and function of terrestrial ecosystem. This project has been integrated with other terrestrial studies.

Annual reports are available from Research Management Division.

Contractor: G. LaRoi, University of Calgary

Funding: $87 508.50 (Research Management Division)

PUBLICATIONS

Case, J.W. 1983. Biomonitoring of air pollution in Alberta with lichens and mosses. Prep. for Alberta Environment, Research Management Division. RMD Report OF-52. 154 pp.

Colley, D.G., R.W. Poon, M.J. Zelensky, and L. Zanzotto. 1984. Alberta oxides of nitrogen emissions forecast 1980 to 2000. Prep. for Alberta Environment, Research Management Division by Western Research, Division of Bow Valley Resources Ltd. RMD Report 84/26. 101 pp.

Krouse, H.R. and J.W. Case. 1983. Sulphur isotope abundances in the Alberta Oil Sands Environmental Research Program study area. Prep. for Alberta Oil Sands Environmental Research Program by University of Calgary Interdisciplinary Sulphur Research Group (UNISUL) and Department of Physics, University of Calgary. RMD Report OF-55. 99 pp.

Krouse, H.R. and J.W. Case. 1984. Design, development, and field testing of a mobile nine unit high volume air sampler array. Prep. for Alberta Environment, Research Management Division by Physics Department, University of Calgary. RMD Report OF-69. 45 pp.

LaRoi, G.H. and M. Ostafichuk. 1983. Structural dynamics of boreal forest ecosystems on three habitat types in the Hondo-Lesser Slave Lake area of north central Alberta in 1981. Prep. for Alberta Environment, Research Management Division by Department of Botany, University of Alberta. RMD Report OF-64. 110 pp.

LaRoi, G.H., M.S. Ross, and M. Ostafichuk. 1983. Structural dynamics of boreal forest ecosystems on three habitat types in the Hondo-Lesser Slave Lake area of north central Alberta in 1982. Volume I: Text; Volume II: Appendix. Prep. for Alberta Environment, Research Management Division by Department of Botany, University of Alberta. RMD Report OF-65. 2 vols.

Nosal, M. 1984. Atmosphere-biosphere interface: probability analysis and an experimental design for studies of air pollutant-induced plant response. Prep. for Alberta Environment, Research Management Division by Statistical Research Laboratory, University of Calgary and Statscon, Statistical Consulting Co. RMD Report 83/25. 98 pp.

Ostafichuk, M. and G.H. LaRoi. 1983. Progress report for 1982: Pinus Banksiana-dominated permanent sample plots in the Athabasca Oil Sands. Prep. for Alberta Environment, Research Management Division by Department of Botany, University of Alberta. RMD Report OF-66. 189 pp.

Sandhu, H.S. and R.P. Angle. 1984. Air quality and acid rain: an overview. 26 pp. (Paper prep. for "Impacts of Science and Technology on Environments," a lecture series organized by Edmonton Public School Board.)

ENVIRONMENTAL ASSESSMENT PROGRAM

The Environmental Assessment Program was designed to provide a focus for the measurement and evaluation of environmental trends and conditions and the development of methodologies for environmental evaluation. Results of the research will provide scientific support for Alberta Environment's regulations and guidelines and supply input to the management decision-making process.

Research activity under this program continued to provide research information dominated in 1983/84 by three major projects. The Co-operative Program in Surface Water Engineering continued to provide research information to the Technical Services Division of Alberta Environment in the areas of fluvial mechanics and river engineering, surface water hydrology, sediment yield studies, and ice formation and break-up in streams. A second major project resulted in the completion of a three-dimensional model of the hydrostratigraphy, hydrodynamics, and hydrochemistry of the Cold Lake Oil Sands area. This model was successfully tested using real data. The third project, a comprehensive study of the stability of Turtle Mountain, produced milestone achievements in two of its components: (1) the aerial photogrammetric network was successfully tested; and (2) the fourth and final phase of the monitoring of the South Peak was completed. Results from these studies, and from other ongoing studies of electronic distance monitoring, seismic monitoring of the old Frank Mine workings, and the collection of year-round climatological data, will provide an assessment of the current status and future requirements for monitoring the mountain's stability.

A new project was initiated in 1983/84. The purpose is to develop a model to assess snowmelt infiltration into frozen prairie soils. This will make forecasting of soil moisture conditions possible for these soils in early spring, to enabling farmers to assess the crop growth potential for the growing season. Also, the results will be useful for forecasting river flows.

The Environmental Assessment Program also included support for graduate research programs in the areas of flow in curved channels, winter oxygen deficits in Alberta lakes, and the development of a flatland hydrology simulation model. Also a grant was also made to contribute to the production of a thirteen-program water resources research television special.

During the 1983/84 fiscal year, it became evident that the broad scope of this program made it difficult to formulate and implement long-term planning and integration of its allocated research activities. A decision was made to divide this all-encompassing program into three discrete programs: (1) the Water Resources Research Program; (2) the Geosciences Program; and (3) the Air Quality/Climatology Program. Work on the definition and planning of these programs was begun during this fiscal year, with formal program implementation scheduled for 1985/86.

PROJECTS

A Regional Assessment of Hydrogeological and Hydrochemical Conditions in the Cold Lake Oil Sands Deposit

This project is an integral part of the department's effort to assess the extent and quality of groundwater resources in the Cold Lake region and to protect the resources from contamination by industrial activity. At present, no technology exists for a quantitative prediction of the potential regional scale effects of lost process or wastewaters on a pre-existing groundwater regime, in three dimensions in the presence of high pressure, high temperature steam injected in a widely distributed pattern of boreholes. This project seeks to establish such a technology through the development of a three-dimensional framework of the hydrostratigraphy, hydrodynamics, and hydrochemistry of the Cold Lake Oil Sands area. It will also identify the processes inherent to both in situ recovery and deep waste disposal methods, and will evaluate their possible effects on both local and regional groundwater regimes. Recommendations will be made for further study aimed at the quantification of these potential impacts for both local and regional scales.

Contractor: Dr. G. Gabert, Alberta Research Council
Funding: $229 000.00 (Research Management Division)
$104 607.00 (Alberta Research Council)

Deformation Monitoring of Turtle Mountain by High-Precision Photogrammetry

The purpose of this project was to develop, test, and implement a photogrammetric monitoring system for the South Peak of Turtle Mountain which is capable of detecting multi-point movements to an accuracy level of 10 mm.

Contractor: Dr. C.S. Fraser, University of Alberta
Funding: $12 000.00 (Research Management Division)

Monitoring the South Peak of Turtle Mountain: Phase IV

This study was undertaken to determine whether a mass of rock outlined by Allan (1933) on Turtle Mountain is in motion and is therefore likely to slide into the Crowsnest Valley in the future. A further objective is to develop techniques for monitoring the stability of large rock masses.

Phase I of this project, in 1980, involved the continued monitoring of the crude network established by Allan in 1933 and the installation of an improved monitoring network. The Phase II monitoring of this network in 1981 detected some significant movements. Detailed geotechnical mapping of the rock mass in 1982 (Phase III) demonstrated possible movement modes.

The objectives of Phase IV were to continue monitoring in 1983, summarizing and standardizing the monitoring data, extending the geotechnical mapping component and mapping the extent of ground subsidence over the Frank Mine. Consideration will also be given to expanding the trilateral sign network.

Contractor: Dr. M. Cruden, University of Alberta
Funding: $20 000.00 (Research Management Division)

Turtle Mountain Seismicity Study

Following the disastrous 1903 rock slide on Turtle Mountain which partially destroyed the town of Frank, coal mining continued along another 2000 metres of the seam until 1918. Active collapse features are visible on the ground along part of this seam directly south of the 1903 slide. By placing seismic recording instruments in the immediate vicinity of this area of instability, the goal of this study is to identify and locate any seismic events occurring in this area and to determine their usefulness as precursors of a further slide.

Contractor: Dr. D.K. Bingham, Earth Sciences Division
Funding: $10 000.00 (Research Management Division) (Capital Expenditure)

Turtle Mountain Weather Station

Data collected from a weather station located on the peak of Turtle Mountain are being used to determine meteorological patterns required for measurement adjustment in the concurrent seismic monitoring, extensometer

measurement, and electronic distance (remote laser) measurement studies. The incorporation of weather data into proposed geologic investigations of the mountain will explore the possibility of meteorological variables directly affecting rock stability. In addition, this project explores the feasibility of collecting year round data from a weather station of this type, situated in a remote location exposed to extreme environmental conditions and remaining physically inaccessible for eight months of the year.
Funding: None in 1983/84

Co-operative Program in Surface Water Engineering

This program is a continuation of joint research projects in fluvial mechanics and river engineering, surface water hydrology, sediment yield studies, and ice formation and breakup in streams. This is a joint program with the Department of Transportation and Alberta Research Council.

Projects within the program are sited throughout Alberta and are designed to investigate long-term, slowly changing, or randomly occurring hydrologic phenomena. Most of the processes must be observed continuously over decade time scales.

Individual studies are identified by line agencies within Alberta Environment and Alberta Transportation on the basis of their impact on public safety, protection of property, or a defined need for information to be used in the design of hydraulic structures. Information derived from the program is also used for enforcement of the Water Resources Act and Regulations.
Contractor: Dr. R.A. Harrington, Alberta Research Council
Funding: $153 000.00 (Research Management Division)
$332 320.00 (Alberta Research Council)
$179 332.00 (Alberta Transportation)

Development of a Flatland Hydrology Simulation Model

A model is proposed that will maintain a spatially varied soil moisture budget for a flatland watershed. The concepts of potential and

actual contributing area will be utilized to determine the depression storage losses, thereby allowing more accurate determination of the excess rainfall that will comprise runoff. Potential and actual contributing area relationships will be determined for a number of suitable prairie watersheds.
Contractor: Dr. J. Verschuren, Mr. J. Byrne, University of Alberta
Funding: $15 000.00 (Research Management Division) (Student Grant)

Determination of the Roughness Length in the Athabasca Oil Sands Region

The Gaussian frequency distribution model developed for the Research Management Division (RMD) provides a reasonable approximation of the ground level concentrations (g.l.c.) of pollutants emitted into the atmospheric boundary layer from point sources. Roughness length (Z_o), a measure of how much mechanical mixing is generated by wind blowing over a particular surface, is a key variable in the model. Currently, subjectively determined roughness length values are used in the model. These values, however, are not representative of actual conditions. The location and magnitude of the g.l.c. can therefore be altered with slight variations in Z_o.

The project proposes to increase the reliability of the Gaussian model by determining a more representative value of Z_o for the Oil Sands area. The model will then be a more powerful tool for reliably predicting ground level concentrations of pollutants. To facilitate this, the project will

(i))empirically estimate Z_o from existing minisonde and acoustic sounder data collected in the AOSERP area by matching the lower portion of the wind profile to the logarithmic law profile, and

(ii) evaluate the feasibility of using aircraft derived measurements to estimate Z_o. Aircraft derived Z_o values will be correlated with empirically derived values to ascertain the validity and reliability of this technique.

Contractor: R. Rudolph, INTERA Technologies Ltd.
Funding: $44 000.00 (Research Management Division)

Development of a Model to Predict Winter Oxygen Deficits in Local Lakes of Central Alberta

This project was designed to measure winter oxygen depletion in several local lakes of central Alberta with a goal to develop a model to predict the process.

Contractor: Dr. E. Prepas, Mr. J. Babin, University of Alberta
Funding: $7 500.00 (Research Management Division) (Student Grant)

Dickson Dam Monitoring Program

Alberta Environment is the proponent for construction of the Dickson Dam and certain commitments were made in the original environmental impact assessment (EIA) for monitoring of the reservoir during and after filling. This monitoring program is being developed jointly by Research Management Division, Pollution Control Division, and Planning Division of Alberta Environment, Fish and Wildlife Division of Energy and Natural Resources and by the Animal Sciences Wing of the Alberta Environmental Centre at Vegreville.

Contractor: J. Moore, Animal Sciences Wing, Alberta Environmental Centre
Funding: Provision of one wage position at $25 000.00 (Research Management Division)

Flow in Curved Channels: Phase II

Phase I of this research produced a state-of-the-art review which successfully fulfilled its objectives of (1) obtaining and evaluating a consensus on the present understanding of the mechanics of flow in curved channels; and (2) identifying and cataloguing existing predictive methods and modelling techniques.

The Phase II study is intended to quantify flow velocity distributions, water surface elevations, and both bed and wall stress distributions at curves in open channels. Specific areas to be addressed are an evaluation of developing flow velocities and shear stresses along a channel bend for design of the longitudinal extent of protection works, and an evaluation of expected scour depths for design of riprap launching aprons.

Contractor: N. Rajaratnam, A. Peterson, and P. Steffler, University of Alberta

Funding: $15 300.00 (Research Management Division) (Student Grant)

Flow in Curved Channels with a Varying Bank Slope

The objective of this study is to evaluate developing velocities and shear stresses along a channel bend, with various bank slopes, for design of vertical zoning and size of riprap protection works. The fully three-dimensional "developing" flow in a curved channel will be studied with the ultimate purpose of providing more accurate design parameters for bank-protection works. Specific areas are an evaluation of the vertical variation of shear stress and velocity near a sloping bank, and evaluation of the variation of velocity and shear stress near banks of different slopes.

Contractor: Dr. N. Rajaratnam, Mr. A. Peterson, Ms. F. Hicks, University of Alberta

Funding: $7 000.00 (Research Management Division) (Student Grant)

Production Grant for a Water Resources Special on Cable Television: Energy Perspectives

This grant will contribute to the production of the following 13-part series on Canada's water resources for viewing on a national cable television network:

Programs:

1. An Over-View. A look at Canada's water resources, major river systems and lakes, and water supply and demand.
2. Nature's Lifeline. An interview with Dr. Robert Lane.
3. Water and Alberta. A look at Alberta's water resources policies and principles.
4. Irrigation. A look at an agricultural practise that results in a six-fold increase in production.
5. The Alberta Water Resources Commission. An interview with Henry Kroeger, Chairman.
6. The Dickson Dam. A forum for a major film on a multi-purpose project.

7. Municipal and Industrial Water Use. An interview with Dr. Dickson Thompson and a look at recycling sewage.
8. The South Saskatchewan Basin Study. A detailed report on one of the most important studies currently under way, affecting all Western Canadians.
9. The Prairie Water Board. A look at one of Canada's most important technical inter-provincial boards.
10. Hydro-Electric Projects. An examination of the renewable energy from a source that now provides over 35% of Canada's electrical energy.
11. International Water Outlook. An overview of plans from the World Waste Congress, the United Nations, and the New Orleans Fair.
12. Conservation. What we can do to conserve our freshwater resources.
13. The Future. A look at future plans, projects, developments, and requirements.

Funding: $5 000.00 (Research Management Division)(Grant)

A Review and Synthesis of Available Information Pertaining to Urban Air Quality Research Needs in Alberta

Urban air quality is a leading environmental concern in Alberta as evidenced by recently published reports funded by the Research Management Division. Consequently, to facilitate the comprehensive and effective planning and development of an urban air quality research program, a project was initiated which would synthesize available information pertaining to urban air quality research in Alberta and review it in the context of national and international activities. Long- and short-term research and monitoring requirements pertinent to urban air quality research in Alberta will be identified. The identification of such research needs will expedite the strategic planning of an urban air quality research program.

Contractor: T. Jandali, ESL, Environmental Sciences Limited

Funding: $25 000.00 (Research Management Division)

Snowmelt Infiltration to Frozen Prairie Soils

The study is concerned with snowmelt infiltration to frozen soils under land use practices common to dryland farming areas encountered throughout much of the prairies. Work will concentrate on the development of an algorithm describing the phenomenon that eventually may be used to replace the "land routine" in digital models used in streamflow synthesis and forecasting. This algorithm will be based on field measurements of "overwinter" soil mixture changes and snowmelt infiltration which have been collected by the researcher during the past three years.

Contractor: Dr. D.M. Gray, University of Saskatchewan

Funding: $17 000.000 (Research Management Division)

Synthesis and Analysis of the Ellerslie Acoustic Doppler Data

The project proposes to (i) perform a quality assurance of the acoustic doppler data collected at the Ellerslie Air Pollution Meteorology Station, and (ii) provide a detailed analysis of the vertical profiles of wind speed and direction for the lower 500 m of the atmosphere. The analysed data will be used to derive turbulence and dispersion characteristics, roughness length and frictional velocity parameters; parameters important to the transport, dispersion, and deposition of air pollutants.

Through an improved understanding of atmospheric processes in the planetary boundary layer, the project will assist in the (i) development of air quality control guidelines and recommendations for stack design and supplementary control systems; (ii) verification and improvement of existing air quality models; and (iii) development and implementation of more sophisticated models of pollutant transport and dispersion.

Contractor: D. Leahey, Western Research

Funding: $31 000.00 (Research Management Division)

PUBLICATIONS

Anderson, E.G. and P.C. Stoliker. 1983. Remote EDM monitoring of fractures on Turtle Mountain: Phase I. Prep. for Alberta Environment, Research Management Division by Division of Surveying Engineering, University of Calgary. RMD Report OF-57. 27 pp.

Andres, D.D. 1983. Pier scour in cohesive materials. IN Proceedings of the Workshop on Bridge Hydraulics. April 1983; Banff, Alberta. Alberta Research Council, Contribution Series Paper 1214.

Andres, D.D. In prep. The hydraulic erodability of cohesive materials. Alberta Research Council, Internal Report SWE 83-04.

Andres, D.D. and P.F. Doyle. 1983. Analysis of breakup and ice jams on the Athabasca River at Fort McMurray, Alberta. Submitted to the Canadian Journal of Civil Engineering. Alberta Research Council, Contribution Series Paper 1214.

Ashmore, P. and G. Parker. 1983. Confluence scour in coarse-braided streams. Water Resources Research 19(2): 392-402.

Beck, S.M., R.A. Harrington, and D.D. Andres. In prep. Lateral channel stability of the Pembina River near Rossington, Alberta. Alberta Research Council, Internal Report SWE 83-02.

Cruden, D.M. 1983. Monitoring the south peak of Turtle Mountain: Phases 2 and 3. Prep. for Alberta Environment, Research Management Division by Department of Civil Engineering, University of Alberta. RMD Report OF-59. 51 pp.

Cruden, D.M. 1983. Monitoring the south peak of Turtle Mountain. Phase 3: possible modes of ground movement. Prep. for Alberta Environment, Research Management Division by Department of Civil Engineering, University of Alberta. RMD Report OF-60. 47 pp.

Elhadi, N., R.A. Harrington, I. Hill, Y.L. Lau, and B.G. Krishnappan. 1983. River mixing: a state of the art report. Accepted for publication in the Canadian Journal of Civil Engineering.

Fraser, C.S. 1983. Deformation monitoring of Turtle Mountain by high-precision photogrammetry: final report. Prep. for Alberta Environment, Research Management Division by Division of Surveying Engineering, University of Alberta. RMD Report L-83. 42 pp.

Fraser, C.S. 1983. Deformation monitoring of Turtle Mountain by high-precision photogrammetry: external appendix. Prep. for Alberta Environment, Research Management Division by Division of Surveying Engineering, University of Calgary. RMD Report OF-62. 1 vol.

Harrington, R.A. and R. Gerard, eds. In prep. Proceedings of the Workshop on Bridge Hydraulics. April 1983; Banff, Alberta.

Harrington, R.A. and D.G. McLean. 1983. Field observations of river bed scour on the Peace River near Fort Vermilion, Alberta. Submitted to the Canadian Journal of Civil Engineering. Alberta Research Council, Contribution Series Paper 1215.

Harrington, R.A. and D.G. McLean. 1983. Field observations of river bed scour on the Peace River near Fort Vermilion, Alberta. IN Proceedings of the Workshop on Bridge Hydraulics. April 1983; Banff, Alberta. Alberta Research Council, Contribution Series Paper 1215.

Hudson, H.R. 1983. Discussion of bedload and size distribution in a paved gravel bed stream. Submitted to Journal of Hydraulic Engineering, ASCE. Alberta Research Council, Contribution Series Paper 1155.

Hudson, H.R. 1983. Evalution of selected bed load formulae in a steep gravel bed river. IN Proceedings of the 6th Canadian Hydrotechnical Conference. June, 1983; Ottawa, Ontario. Alberta Research Council, Contribution Series Paper 1181.

Hudson, H.R. 1983. Hydrology and sediment transport in the Elbow River basin. Prep. for Alberta Environment, Research Management Division by Department of Geography, University of Alberta. RMD Report OF-63. 322 pp. (Ph.D. Thesis.)

Hudson, H.R. In prep. Fluvial sediment yield in Alberta. IN Proceedings of the Soil Erosion and Land Regradation Conference. November 1983; Saskatoon, Saskatchewan.

Hudson, H.R. In prep. Hydrometeorology of the Lower Beaver River Basin, East-Central Alberta. Alberta Research Council, Internal Report SWE 83-03.

Hudson, H.R. In prep. Sediment yield research in Alberta. Alberta Research Council, Internal Report SWE 83-05.

Hudson, H.R. 1984. Aspects of the hydrologic and sediment regimes of the Muskeg River basin and the consequences of vegetation removal. Prep. for Alberta Environment, Research Management Division by Department of Civil Engineering, Alberta Research Council. RMD Report L-84. 46 pp.

Huiskamp, W.J. 1983. Ice force measurements on bridge piers, 1980-81. Alberta Research Council, Internal Report SWE 83-01.

Ladd, T., F. Cusack, and J.W. Costerton. 1983. A study of the bacteriology of the epilithic, planktonic, and sediment communities in the Bow River, Alberta. Prep. for Alberta Environment, Research Management Division by University of Calgary. RMD Report OF-56. 99 pp.

Manz, David H. 1984. Performance evaluation of distributary canals in southern Alberta. Prep. for Alberta Environment, Research Management Division by Department of Civil Engineering, University of Calgary. RMD Report OF-72. 38 pp.

Maruschak, O. 1983. Surface water quality management in Alberta: policy and institutional arrangements. Prep. for Alberta Environment, Research Management Division. RMD Report OF-58. 175 pp.

Steffler, P.M., N. Rajaratnam, and A.W. Peterson. 1983. Flow in curved channels: a review of the present knowledge. Prep. for Alberta Environment, Research Management Division by Department of Civil Engineering, University of Alberta. RMD Report L-82. 60 pp.

ENVIRONMENTAL CONTAMINANTS PROGRAM

The Environmental Contaminants Program was restricted to addressing only some specific priority contaminants. The objectives of this program included: (1) the development of a mechanism for identifying and assigning research priorities to contaminants of concern to Alberta; and (2) the development of a mechanism whereby information about the fate and effects of contaminants can be accumulated in order to direct mitigative action.

Major research activities under this program in 1983/84 included an ongoing project seeking to identify the chemical components of the products of in situ oil sands combustion processes and to estimate the potential environmental hazards. Another project involved further testing and refinement of a model developed to improve the prediction of phosphorus content in Alberta lakes.

A graduate student thesis on an improved methodology for calculating nutrient budgets for shallow productive lakes in Alberta was completed in 1983/84. Support was provided for the first year of a two-year graduate program to investigate the temporal variation of stream phosphorus loading and partitioning.

A project was initiated for the analysis of chemical and biological aquatic monitoring data in the Athabasca Oil Sands area. Research was also begun on a one-year project on surface water contamination from sanitary landfills.

PROJECTS

Analysis of Aquatic Monitoring Data in the Athabasca Oil Sands Area

The objective of this project is to analyse the relationship between water quality and benthic invertebrate data based on samples collected during the monitoring programs of the Athabasca River. Specifically, this task will involve the use of multivariate statistical analysis to: (1) evaluate which few water quality parameters of the many measured will be useful in long-term monitoring programs designed to detect municipal and industrial impacts; and (2) determine if water quality parameters can be used to predict the distribution and abundance of benthic invertebrates at sites within the study area.

Contractor: Dr. G. Walder, Sigma Biometrics

Funding: $15 000.00 (Research Management Division)

Analysis of Flare Stack Emissions

The efficiency of flaring in the disposal of reduced and oxidized sulphur compounds (inorganic and organic) as documented by the Environmental Council of Alberta (ECA) in the 1972 Sour Gas Hearings, has been a concern for several years. Despite the flare stack's ubiquity and long history of use, the published literature contains very little information relating to its performance. It has, therefore, been virtually impossible to establish design standards or operating guidelines.

Further, combustion which occurs externally is dependent on variable temperatures across the flame and a limited retention time of the sulphur compounds. Consequently, the possibility of incomplete combustion may have significant implications for air quality.

In order to prevent and control pollution from flares, criteria must be established for (i) design of the stack, flare tip, shroud, ignition system, flow rate, and (ii) operation of the flare by keeping the controlling combustion parameters within prescribed limits. To address these areas, the project objectives will include.

1. a literature review of flare combustion efficiencies and available technology for measuring flaring activity and volumes/compositions of flared gases; and

2. the measurement of heavy metals and reduced/oxidized sulphur compounds in raw and/or acid gas stream prior to flaring and the measurement of reduced/oxidized sulphur compounds along the axis of a continuous flare plume to determine combustion efficiencies.

Contractor: D. Leahey, Western Research
Funding: $46 000.00 (Research Management Division)

Improving the Estimate of Phosphorus in Local Lakes

The objectives of this project were to develop a model to predict the portion of the phosphorus pool tied up in the larger plankton of local Alberta lakes and to improve the models for predicting lake-water phosphorus.

Contractor: Dr. E. Prepas, University of Alberta
Funding: $20 000.00 (Research Management Division) (Grant)

International Conference on Oil and Freshwater: Chemistry, Biology, and Technology

This grant will contribute to the organization and presentation of a major international conference on oil pollution of freshwater, to be held October 15 to 19, 1984. The conference will bring together experts from the disciplines of chemistry, biology, and engineering. By means of invited and contributed papers, it will serve as a review of all available and current research on oil pollution of freshwater systems. Special attention will be given to contamination resulting from oil spills, synthetic crude oil production, and industrial/urban runoff.

Contractor: Dr. S.E. Hrudey, University of Alberta
Funding: $10 000.00 (Research Management Division) (Grant)

Oil Sands In Situ Combustion Products

This project was undertaken to chemically identify contaminants in the fluids and gases associated with in situ fire-flood produced bitumen, and to identify the possible environmental hazards and human health risks arising from these toxic and carcinogenic materials.

Contractor: E. Peake, Kananaskis Centre for Environmental Research, University of Calgary

Funding: $50 000.00 (Research Management Division) (1982/83 for work in 1983/84)
$50 000.00 (AOSTRA)

Prediction of Productivity and the Behaviour of Phosphorus in Shallow Non-Stratified Lakes

The purpose of this project was to collect data for the calculation of the nutrient budget for three shallow productive lakes in the Edmonton area and estimate return of phosphorus from the sediments by the difference between inputs and outputs. The data will be used, along with literature examples, to develop general models for these unusual lakes, focusing on both quantity and rate of nutrient return from the sediments.

Contractor: Dr. E. Prepas, Mr. E. Riley, University of Alberta
Funding: $10 500.00 (Research Management Division) (Student Grant)

Surface Water Contamination from Sanitary Landfills

The Clover Bar sanitary landfill is located in an old gravel bed on the banks of the North Saskatchewan River. The probability of contaminating groundwaters passing through the gravel bed and the waters of the adjacent river is very high. The proposed study will indicate whether toxic compounds are escaping from the site, the level of hazard this escape presents to the local environment, and whether a problem exists that requires remedial action. The toxicity of the leachates will be determined by bacterial luminescence assay. This study will also determine the organic compounds that are responsible for the toxicity found in leachates and river waters.

Contractor: B.L. Baker, Kananaskis Centre for Environmental Research, University of Calgary
Funding: $ 8 550.00 (Research Management Division)

Temporal Variation of Stream Phosphorus Loading and Partitioning

The objective of this project is to develop a model to predict how seasonal changes will influence phosphorus loading in streams. This will be accomplished by testing for temporal variation in phosphorus concentration and

partitioning in two headwater streams flowing through soft rocks or glacial till in undisturbed forest watersheds.

Contractor: Dr. E. Prepas, Ms. N. Munn, University of Alberta

Funding: $ 7 000.00 (1983/84) (Grant)

PUBLICATIONS

Boerger, H. 1983. Distribution and abundance of macrobenthos in the Athabasca River near Fort McMurray. Prep. for Alberta Environment, Research Management Division by Department of Physics, University of Calgary. RMD Report OF-53. 77 pp.

Prepas, E.E. 1983. The influence of phosphorus and zooplankton on chlorophyll levels in Alberta lakes. Prep. for Alberta Environment, Research Management Division by Department of Zoology, University of Alberta. RMD Report 83/23. 111 pp.

Prepas, E.E. 1983. Total dissolved solids as a predictor of lake biomass and productivity. Can. J. Fish. Aquat. Sci. 40(1): 92-95.

Prepas, E.E. and D.O. Trew. 1983. Evaluation of the phosphorus-chlorophyll relationship for lakes of the Precambrian Shield in western Canada. Can. J. Fish. Aquat. Sci. 40(1): 27-35.

Prepas, E.E. and J. Vickery. 1984. The contribution of particulate phosphorus (250 um) to the total phosphorus pool in lake water. Can. J. Fish. Aquat. Sci. 41(2): 351-363.

Prepas, E.E. and J. Vickery. 1984. Seasonal changes in total phosphorus and the role of internal loading in western Canadian lakes. Paper accepted for publication by Internationale Vereinigung fur Theoretische and Angewande Limnologie.

Riley, E.T. and E.E. Prepas. 1983. The role of internal phosphorus loading in two shallow, productive lakes in Alberta, Canada. Can. J. Fish. Aquat. Sci. 40.

RECLAMATION PROGRAM

Research Management Division staff continued essentially full-time managerial and administrative responsibilities for provincial reclamation research in association with the interdepartmental Reclamation Research Technical Advisory Committee (RRTAC). In 1983, RRTAC committed approximately $1.5 million to a reclamation research program with sub-programs in the northeast oil sands region, in the coal-bearing region of the province's agricultural zone, and in the mountains and foothills. RMD scientists contributed to the development of programs and projects in these areas through participation in government-industry program committees. In the province, such research concentrates on: (1) determining methods of rebuilding productive soils (physically, chemically, and biologically); (2) identifying changes in the quantity and quality of surface water and groundwater following disturbance and reclamation; (3) developing native plant species for reclamation; (4) controlling erosion; and (5) improving materials-handling operations.

Reclamation research was co-ordinated within Alberta Environment by the Reclamation Research Co-ordinating Committee, chaired by the Research Management Division.

A synthesis of reclamation information relevant to Alberta from over 1700 references in the international reclamation literature was published in March 1984.

Approximately 800 references have been collected for inclusion in the second edition of the publication Land Surface Reclamation: An International Bibliography. The division's collection of 3000 reclamation publications (books, articles, and proceedings) was transferred to the departmental library to allow wider access to the material.

An inventory of peat analyses methods from international research institutes has been written and will be available in the fall of 1985. This inventory will be used by the International Peat Society to help develop standard international methodology.

The senior program manager has occupied the position of President of the Canadian Land Reclamation Association (CLRA). In addition, an RMD

scientist was elected Secretary-Treasurer of the Alberta Chapter of the CLRA. The senior program manager and an RMD scientist edit the quarterly Reclamation Newsletter.

Reports on reclamation projects are published through RRTAC rather than by RMD. A list of Reclamation Research Reports (RRTAC) follows:

RRTAC PUBLICATIONS

Cameron, N.S.C. **The role of organic compounds in salinization of Plains Coal mining sites.** RRTAC Report 80-3. 46 pp.

Hardy Associates (1978) Ltd. **Evaluation of pipeline reclamation practices on agricultural lands in Alberta.** RRTAC Report 83-3. 205 pp.

Monenco Consultants Ltd. **Soil reconstruction design for reclamation of oil sand tailings.** RRTAC Report 83-1. 185 pp.

Powter, C.B. and H.P. Sims. **A bibliography of baseline studies in Alberta: Soils geology, hydrology and groundwater.** RRTAC Report 82-2. 97 pp.

Sims, H.P. and C.B. Powter. **Land surface reclamation: An international bibliography.** 2 vols. RRTAC Report 82-1. 292 pp.

Sims, H.P., C.B. Powter, and J.A. Campbell. **Land surface reclamation: A review of international literature.** 2 vols. 1549 pp.

Techman Engineering Ltd. **Woody plant establishment and management for oil sands mine reclamation.** RRTAC Report 83-5. 124 pp.

Techman Engineering Ltd. **Propagation study: Use of trees and shrubs for oil sand reclamation.** RRTAC Report 84-2.

Walker, D.G. and R.L. Rothwell. **1980 survey of reclamation activities in Alberta.** RRTAC Report 81-2. 76 pp.

Watson, L.E., R.W. Parker, and P.F. Polster. **Manual of plant species suitability for reclamation in Alberta.** 2 vols. RRTAC Report 80-5. 541 pp.

Ziemkiewicz, P.F., S.K. Takyi, and H.F. Regier. **IN: Proceedings of workshop on reconstruction of forest soils in reclamation.** RRTAC Report 80-4. 160 pp.

Ziemkiewicz, P.F. R. Stien, R. Leitch, and G. Lutwick. **IN: Proceedings of workshop on coal ash and reclamation.** RRTAC Report 81-3.

Ziemkiewicz, P.F. **IN: Proceedings of workshop on effects of coal mining on eastern slopes hydrology.** RRTAC Report 83-4. 123 pp.

Ziemkiewicz, P.F. **The Alberta Government's Reclamation Research Program 1983.** RRTAC Report 84-3. 29 pp.

PROJECTS

Mycorrhizal Development on Severely Disturbed Soils

This study examined the potential of natural inoculum in stored peat and developed effective mycorrhizal associations for oil sands reclamation.

Four reports to be published in 1985 will describe the nature and rate of microorganism establishment in mine spoils, and the influence of various reclamation treatments in creating a stable plant-soil system.

Contractor: D. Parkinson, University of Calgary

Funding: $86 140.00 (Land Conservation and Reclamation Council-Heritage Trust Savings Fund)

Oil Sands Tailings Soil Reconstruction

Using the results of a study undertaken to determine the minimum physical, chemical, and biological properties of soil required to support three vegetation types, a joint government-industry reclamation project was initiated to identify methods of reconstructing soils from tailings sand, peat, and clayey materials that will support a self-maintaining woody shrub and tree cover. A flat tailings sand experimental site was constructed on the Syncrude Canada Ltd. lease at Fort McMurray.

Fifty-four plots, 22 m wide and 44 m long, were created. Treatments included: (1) three organic carbon levels provided by mixing peat into the tailings sand; (2) three levels of clay provided by mixing fine-textured overburden into the tailings sand; and (3) two mixing depths.

Baseline soil data have been collected and ten tree and shrub species will be planted in the fall of 1984.

Contractor: H. Martens, Hardy Associates (1978) Ltd.

Funding: $108 106.00 (Land Conservation and Reclamation Council-Heritage Trust Savings Fund)

$108 106.00 (Syncrude Canada Ltd., Suncor Inc., and the Oil Sands Industry Environmental Association)

Assessment of Reclamation Potential and Hydrologic Impacts of Large-Scale Surface Mining of Coal in Plains Areas in Alberta

The objective of this project was to develop a predictive framework for projecting both the success of reclamation and the long-term impact of mining on water resources. Differences in physical and chemical properties of the pre-mining soils, overburden, and subsurface water were used as keys to gauge post-mining conditions. The predictive framework is to be based on an understanding of the processes acting within the landscape so that, in the future, mine sites that are not totally analogous to those that have been studied can also be evaluated.

The project involved an holistic approach to reclamation through the integration of studies of geology, hydrogeology, and soils, not only in a proposed mining area, but also in the adjoining unmined areas. This approach permits the assessment of impacts and long-term performance in both areas.

Twenty-eight final reports will be completed in 1985.

Contractor: S. Moran, Alberta Research Council

Funding: $1 010 000.00 (Land Conservation and Reclamation Council-Heritage Trust Savings Fund)

$ 100 000.00 (Alberta Research Council)

Soil Reconstruction Project: Battle River

This study was designed to determine the types and amounts of materials needed to amend sodic mine spoils. The ability to restore and maintain agricultural productivity will be a measure of the success of the various amendments.

Contractor: L. Leskiw, Pedology Consultants

Funding: $140 000.00 (Jointly funded by Land Conservation and Reclamation Council-Heritage Trust Savings Fund; Alberta Power; Luscar Ltd.; and Manalta Coal Ltd.)

Soil Reconstruction Project: Highvale

A project similar to that noted above was initiated at the Highvale mine site. While the purpose of the research was similar, some changes in experimental design were made to account for the different soils, agricultural practices, and end land uses in the area.

Contractor: L. Panek, Monenco Consultants

Funding: $120 448.00 (Jointly funded by Land Conservation and Reclamation Council-Heritage Trust Savings Fund and Transalta Utilities)

Feasibility of Genetic Improvement of Native Alberta Grasses

This project is attempting, through mass selection, to develop improved lines of native Alberta grasses for reclamation, erosion control, and wildlife range improvement in alpine and subalpine areas of Alberta. Responsibility for carrying out the research was transferred to the Alberta Environmental Centre at Vegreville, where work this year concentrated on reviewing previous results and setting up plots for planting trials.

Funding: Work is funded by the Alberta Environmental Centre

International Inventory of Fertility Analysis for Peat Soils

Peat fertility is a poorly understood subject that has received minimal investigation in North America. Under the auspices of the International Peat Society, an RMD scientist is compiling an international inventory of peat analyses methods used by research institutes where more relevant research has been carried out. The inventory will be used to help develop standard international methodology for peat analysis.

Funding: None in 1983/84

Peclamation Research Review

International reclamation literature is being collected by RMD staff and compiled in a bibliography. A computer program has been developed to allow users to search the bibliography. The data base is kept on a SPIRES file at the University of Alberta. An additional 800 references were added to the computer data base in 1983/84.

Divisional staff prepared a synthesis of literature referenced in the bibliography. This report was published in March 1984, and provides direction for further research in the province.

Funding: $17 500.00 (Land Conservation and Reclamation Council-Heritage Trust Savings Fund)

$15 341.00 (Research Management Division)

PUBLICATIONS

Monenco Consultants Ltd. 1983. Soil reconstrction design for the reclamation of oil sands tailings. Prep. by Monenco Consultants Ltd. for the Oil Sands Environmental Study Group and Alberta Land Conservation and Reclamation Council. Report No. OSESG-RRTAC 83-1. 196 pp.

Sims, H.P., C.B. Powter, and J.A. Campbell. 1984. Land surface reclamation: a review of international literature. Prep. for Alberta Land Conservation and Reclamation Council by Research Management Division. Report No. RRTAC 84-1. 2 vols. 1549 pp. (Available from Queen's Printer.)

Trudell, M., A. Maslowski, E. Wallick, and S.R. Moran. 1983. Prediction of groundwater chemistry in reclaimed landscapes. IN Proceedings: Second Alberta Reclamation Conference. February 1983; Edmonton, Alberta. Alberta Chapter Canadian Land Reclamation Association. Publication No. CLRA/AC 83-1. pp. 238-251.

Visser, S., C.L. Griffiths, and D. Parkinson. 1983. Effects of surface mining on the microbiology of a prairie site in Alberta, Canada. Canadian Journal of Soil Science 63: 177-189.

Wallick, E. 1983. Gas composition in the unsaturated zone as an index of geochemical equilibrium in reclaimed landscapes. IN Proceedings: Second Alberta Reclamation Conference. February 1983; Edmonton, Alberta. Alberta Chapter Canadian Land Reclamation Association. Publication No. CLRA/AC 83-1. pp. 225-237.

Zak, J.C. and D. Parkinson. 1983. Effects of surface amendation of two mine spoils in Alberta, Canada, on vesicular-arbuscular mycorrhizal development of slender wheatgrass: A 4-year study. Canadian Journal of Botany 61: 798-803.

SOCIO-ECONOMIC ANALYSIS PROGRAM

This program, which falls into the domain of the division's Human Sciences Group, includes socio-economic analysis of environmental concerns and research into public participation in environmental issues, as well as research evolving from those components of RMD programs having potential for human concern. In addition, members of this team act as advisors on such matters as human health, and public perception and communication of environmental problems. They provide a co-ordinative function in the department and meet with other government agencies.

During the fiscal year, the focus on public perceptions of environmental issues was continued. Data from the 1983 Edmonton Area Study, conducted by the Population Research Laboratory of the University of Alberta, were analysed and the report was placed on open file.

Following intense research and development during 1982, phase one of a project concerning the effects of plant closures was successfully completed, and publication of a report is pending.

The Population Turnover in Fort McMurray: Phase I study was completed in 1982. A questionnaire identifying why people moved from resource towns was designed and pre-tested. Funding for Phase II consists of implementation of the questionnaire to former residents of Fort McMurray.

Background documentation and initial project rationales were developed for research into the origins of public attitudes toward the environment. A series of studies designed to investigate the content of communication about environmental matters with specific reference to the degree and direction of interactions between information programs and public were initiated.

PROJECTS

Edmonton Environmental Survey

The Population Research Laboratory, University of Alberta, conducts a yearly survey, covering many subject areas, of a large population in Edmonton. For three consecutive years, 1980 to 1982, the Human Sciences Group funded the Population Research Laboratory for the inclusion of questions about the environment in order to measure the strength and direction of public perceptions on that subject. Data from the 1983 Edmonton Area Study were analysed and the report placed on open file.

Contractor: H. Krahn, University of Alberta

Funding: $4 000.00 (Research Management Division)

Effects of Plant Closures: Phase I

An assessment of the socio-economic impacts of plant closures on the quality of life of individuals and families within the community of Brooks was completed. Analysis of the data provided the basis for recommendations concerning long- and short-term strategies to reduce the socio-economic impacts of future closures. A comprehensive report is awaiting publication.

Contractor: Anna Parkinson Urban Consultants Ltd.

Funding: $34 500.00 (Research Management Division)

Population Turnover in Fort McMurray: Phase II

A questionnaire identifying why people moved from resource towns was designed and pre-tested in Phase I. Implementation of that questionnaire to former residents of Fort McMurray will identify why people move from resource towns.

Contractor: Thames Group Research

Funding: None in 1983

PUBLICATIONS

Krahn, H. 1983. Environmental issues in Alberta: The opinions of Edmonton residents, 1983. Prep. for Alberta Environment, Research Management Division by Department of Sociology, University of Alberta. RMD Report OF-68. 17 pp.

Krahn, H. 1984. Labour market segmentation in Fort McMurray. Prep. for Alberta Environment, Research Management Division by Department of Sociology, University of Alberta. RMD Report OF-71. 329 pp. (Ph.D. thesis.)

Detomasi, Don et al. In prep. Plant closures: Recession in a prairie town. Prep. for Research Management Division by Anna Parkinson Urban Consultants Ltd.

WASTE MANAGEMENT PROGRAM

The Waste Management Research Program was structured as two separate, although interdependent, research areas reflecting Alberta Environment's mandate for managing waste. These areas or sub-programs were (1) social policy research and (2) technology research.

During the 1983/84 fiscal year, waste management research activities were concentrated on the technology research sub-program, dealing with the solution of problems in engineering design and facility operation. The primary focus was on the assessment of existing technology, development of new technology, and the development of analysis methodology for water and wastewater treatment systems.

The assessment of the effects of chemical coagulants on specific aspects of existing wastewater treatment technologies was addressed by two component studies of a larger project initiated in 1982/83. The first study dealt with possible impacts of phosphorus removal technology on the performance of anaerobic sludge digestion. The second study sought to determine the effect of chemical (alum) coagulation on micro-organism removal in a sewage lagoon prior to spring discharge.

The third study of the project dealt with the feasibility of using the existing water treatment technologies of chemical coagulation and rapid sand filtration for the removal of Giardia cyst-size particles.

Complementary to this study was a project for the development of methodologies to detect Giardia cysts in water supplies.

Support was also provided in 1983/84 for the first year of a three-year graduate student project to investigate the feasibility of using ozone in the treatment of domestic water at the Glenmore Water Treatment Facility.

PROJECTS

Attenuation of Pollutants by Alberta Soils

This study will examine the ability of a series of Alberta soils to attenuate a number of hazardous liquids that are common in our society. Aliquots of the liquids will be added to the tops of columns, each containing a different soil. Testing of the liquids that drain through the soil column will determine any changes that the liquid undergoes as well as the volume of liquid held up by the soil.

Contractor: B.L. Baker, Kananaskis Centre for Environmental Research, University of Calgary

Funding: $ 6 804 (Research Management Division)

Methodology Development for Giardia Analysis

Recent work has shown that the levels of infection for Giardia in wild and domestic animals in Alberta average about 10%. Many of these animals have the potential to introduce cysts to water supplies, thus making them pathogenic to humans. Good progress has been made toward the detection and recovery of cysts in water supplies but the human pathogenicity of such cysts remains undetermined. This project is directed toward applying existing and newly-developed identification methods to Giardia isolated from water supplies. If successful, the results from this project will provide the information and methodology necessary to respond definitely to suspected waterborne outbreaks of giardiasis by confirming the presence or absence of cysts.

Contractor: Dr. P.M. Wallis, Kananaskis Centre for Environmental Research, University of Calgary

Funding: $12 000 (Research Management Division)

Pilot Studies in the Use of Ozone for Domestic Water Treatment

This project is designed as a three-year graduate student project which will investigate the feasibility of the use of ozone in the treatment of domestic water. The study will involve the construction and operation of a

pilot plant at the City of Calgary's Glenmore Water Treatment Facility. The pilot plant will operate for one full year. During the year of operation, particular attention will be paid to contractor design effects, reaction kinetics, reaction products, and microbial inactivation. Secondary effects of colloid stability, water aggressiveness, and persistence of ozone in backwash effluents will be measured. All results will be compared with the existing prechlorination facility.

Contractor: Dr. A. Badakshan, Dr. E. Hargesheimer, University of Calgary
Funding: $15 000 (Research Management Division) (Student Grant)

The Use and Effects of Chemical Coagulants on Water and Wastewater Treatment

This project involves three specific concurrent studies on the use and effects of chemical coagulants on water and wastewater treatment processes. The first study will determine the possible impact of phosphorus removal technology on the performance of anaerobic sludge digestion. The second study will investigate the feasibility of using chemical coagulation and rapid sand filtration for removal of Giardia cyst-size particles. The third study will determine the effect of chemical coagulation on microorganism removal in a sewage lagoon prior to spring discharge.

Contractor: Dr. S.E. Hrudey, University of Alberta
Funding: $20 000.00 (Research Management Division)

PUBLICATIONS

Hrudey, S.E. 1984. Special waste residue management for Alberta. Prep. for Alberta Environment, Research Management Division by Department of Civil Engineering, University of Alberta. RMD Report 84/27. 172 pp.

Lehman, D.L., P.M. Wallis, A. MacMillan, and J.M. Buchanan-Mappin. 1983. Potential health problems caused by disposal to land of sewage sludge containing pathogens. Prep. for Alberta Environment, Research Management Division by the Kananaskis Centre for Environmental Research, University of Calgary. RMD Report 83/21. 172 pp.

Taube, H. and S.E. Hrudey. 1983. Evaluation of organic pollutants in sanitary landfill leachate. Prep. for Alberta Environment, Research Management Division by MacLaren Engineers, Planners and Scientists, Inc. RMD Report OF-61. 158 pp.

COMMITTEES

Committees which have Research Management Division representation are listed below.

DEPARTMENTAL

Ad Hoc Committee on Recommendation 21

Advisory Committee for the Research Study "Determination of the Source of Sulphate in Groundwater in the Lakeside Feedlot Area near Brooks, Alberta"

Air Quality Research Committee

Analytical Services for the Pollution Control Division at the Alberta Environmental Centre, Air Working Group

Analytical Services for the Pollution Control Division at the Alberta Environmental Centre, Aquatic Working Group

Departmental Committee on Acid Deposition (DCAD)

Departmental Sub-Committee on NO_x Control

Directors/Assistant Deputy Minister Environmental Protection Services Committee

Pulp and Paper Mill Effluents Committee

Reclamation Research Co-ordinating Committee (RRCC)

INTERAGENCY/INTERDEPARTMENTAL

Ad Hoc Committee: Weather Monitoring Network (Olympic Secretariat)

Alberta Climate Advisory Committee (Alberta Environment)

Alberta Environmental Centre Technical Advisory Committee (AEC/TAC)

Alberta Environmental Research Trust, Grants Advisory Committee (AERT-GAC)

Alberta Fishways (Alberta Environment, Alberta Energy and Natural Resources, Alberta Transportation, Environment Canada)

Alberta Government/Industry Acid Deposition Research Program (AGIADRP), Human Health Committee

Alberta Government/Industry Acid Deposition Research Program (AGIADRP), Medical Diagnostic Review Project Committee

Alberta Government/Industry Acid Deposition Research Program (AGIADRP), Members Committee

Alberta Government/Industry Acid Deposition Research Program (AGIADRP), Executive Committee

Alberta Government/Industry Acid Deposition Research Program (AGIADRP), Technical Committee

Associate Committee on Scientific Criteria for Environmental Quality (National Research Council, Environmental Secretariat)

Associate Committee on Scientific Criteria for Environmental Quality, Subcommittee on Air (National Research Council, Environmental Secretariat)

Atmospheric Sciences Program Subcommittee (Alberta Research Council)

Canadian Annual Aquatic Toxicity Workshop Steering Committee (Alberta Environment, Alberta Environmental Centre, Environment Canada, Ontario Ministry of the Environment, University of Guelph, University of Alberta, University of British Columbia)

Canadian Climate Planning Board (Environment Canada)

Canadian Land Reclamation Association, Executive Committee

Canadian Meteorological and Oceanographic Society (CMOS), Scientific Committee

Canadian Petroleum Association/Environmental Research Advisory Committee (CPA/ERAC)

Climate Advisory Committee (Olympics Secretariat)

Dickson Dam Monitoring Committee (Alberta Environment, Alberta Environmental Centre, Alberta Energy and Natural Resources)

Federal/Provincial Long-Range Transport of Atmospheric Pollutants (LRTAP), Acid Rain Steering Committee (Environment Canada)

Federal/Provincial Long-Range Transport of Atmospheric Pollutants (LRTAP), Acid Rain Research and Monitoring Co-ordinating Committee (RMCC) (Environment Canada)

Federal/Provincial Long-Range Transport of Atmospheric Pollutants (LRTAP), Acid Rain Research and Monitoring Co-ordinating Committee (RMCC), Atmospheric Sciences Group (Environment Canada)

Intergovernmental Aquatic Toxicity Group (Alberta Environment, Environment Canada, Ontario Ministry of the Environment)

Kananaskis Centre Policy Advisory Committee (University of Calgary)

Lake Wabamun Watershed Advisory Committee (LWWAC) (Alberta Environment, Alberta Parks and Recreation, Alberta Energy and Natural Resources, County of Parkland, Lake Wabamum Preservation Association, Alberta Summer Villages Association, Edmonton Regional Planning Commission, Paul Indian Band, Calgary Power Ltd./TransAlta Utilities, Wabamum Home Owner's Association, Village of

Long-Range Transport of Atmospheric Pollutants in Western Canada (LRTAP) Technical Committee (British Columbia, Alberta, Saskatchewan, Manitoba, Northwest Territories, and Canada)

Mountains and Foothills Reclamation Research Program (MFRRP) (Alberta Environment, Alberta Energy and Natural Resources, Industry)

Mountains and Foothills Reclamation Research Program (MFRRP), Hydrology Subcommittee and Revegetation Subcommittee (Alberta Environment, Alberta Energy and Natural Resources, Esso Resources Ltd., Cardinal River Coal Mines, Luscar Ltd., Manalta Coal Ltd., Union Oil Ltd.)

Oil Sands Soil Reconstruction Project, Steering Committee (Alberta Environment, Alberta Forest Service, Industry)

Oil Sands Reconstruction Project, Technical Committee (Alberta Environment, Alberta Forest Service, Industry)

Panel for Energy Research and Development (PERD) (Alberta Environment, Environment Canada)

Plains Aquatic Research Group (Alberta Environment, Environment Canada, Fisheries and Oceans Canada, Saskatchewan Environment, University of Calgary, Montana State University)

Plains Coal Reclamation Research Program, Steering Committee (PCRRP) (Alberta Environment, Alberta Energy and Natural Resources, Industry)

Plains Coal Reclamation Research Program (PCRRP), Geochemistry Subcomittee and Soil/Crop Subcommittee

Reclamation Research Technical Advisory Committee (RRTAC) (Alberta Environment, Alberta Energy and Natural Resources, Alberta Agriculture, and Alberta Research Council)

Statistics Co-ordinating Committee (Alberta Bureau of Statistics)

Surface Water Research Advisory Committee (Alberta Environment, Alberta Research Council, Environment Canada)

Third International Symposium on Regulated Streams, Organizing Committee (Alberta Environment, Syncrude Canada Ltd., University of Calgary, University of Alberta)

Turtle Mountain Study Team (Alberta Environment, Alberta Energy and Natural Resources, Alberta Disaster Services, Alberta Culture)

United States-Canada Transboundary Air Pollution Impact Assessment Working Group (Environment Canada)

Water Subprogram Committee, Alberta Research Council (Alberta Environment, Alberta Agriculture, Alberta Transportation, Alberta Research Council, University of Alberta, Canada West Foundation, Irrigation Secretariat)

Women's Forum Advisory Committee